



US009143741B1

(12) **United States Patent**
Fu et al.

(10) **Patent No.:** **US 9,143,741 B1**
(45) **Date of Patent:** **Sep. 22, 2015**

(54) **INTERNET PROTOCOL SECURITY CAMERA CONNECTED LIGHT BULB/SYSTEM**

(71) Applicant: **Kuna Systems Corporation**, Millbrae, CA (US)

(72) Inventors: **Sai-Wai Fu**, Los Altos, CA (US);
Haomiao Huang, Berkeley, CA (US)

(73) Assignee: **Kuna Systems Corporation**, Burlingame, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/164,540**

(22) Filed: **Jan. 27, 2014**

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/921,597, filed on Jun. 19, 2013.

(60) Provisional application No. 61/923,931, filed on Jan. 6, 2014, provisional application No. 61/684,310, filed on Aug. 17, 2012, provisional application No. 61/783,474, filed on Mar. 14, 2013, provisional application No. 61/790,865, filed on Mar. 15, 2013.

(51) **Int. Cl.**
H04N 7/18 (2006.01)
H05B 37/02 (2006.01)

(52) **U.S. Cl.**
CPC . **H04N 7/18** (2013.01); **H05B 37/02** (2013.01)

(58) **Field of Classification Search**

CPC H04N 5/23203; H04N 7/18; H05B 37/02
USPC 348/211.2
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2003/0174865	A1 *	9/2003	Vernon	382/105
2003/0210340	A1 *	11/2003	Frederick	
			Romanowich	348/272
2010/0141153	A1 *	6/2010	Recker et al.	315/149
2012/0120243	A1 *	5/2012	Chien	348/159

* cited by examiner

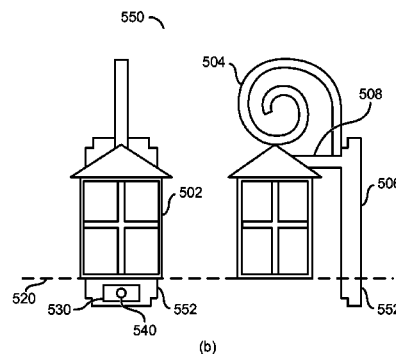
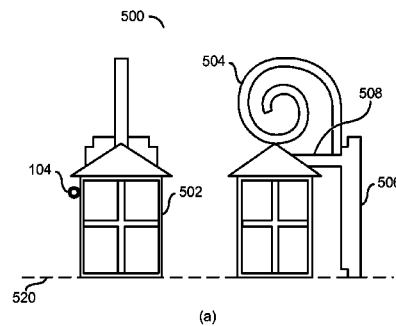
Primary Examiner — Gevelli Selby

(74) *Attorney, Agent, or Firm* — Christopher P. Maiorana, PC

(57) **ABSTRACT**

The present invention concerns an apparatus comprising an antenna module and a control module. The antenna module may be configured to connect and send data to a local network and a mobile handheld device through a wireless connection. The control module may be configured to provide (i) a physical connection to the antenna module, (ii) a power source to an external device, and (iii) a camera sensor to capture still and motion pictures and sounds of a surrounding environment of the apparatus. The pictures may be sent as the data through the wireless connection or through a mobile handheld device.

19 Claims, 14 Drawing Sheets



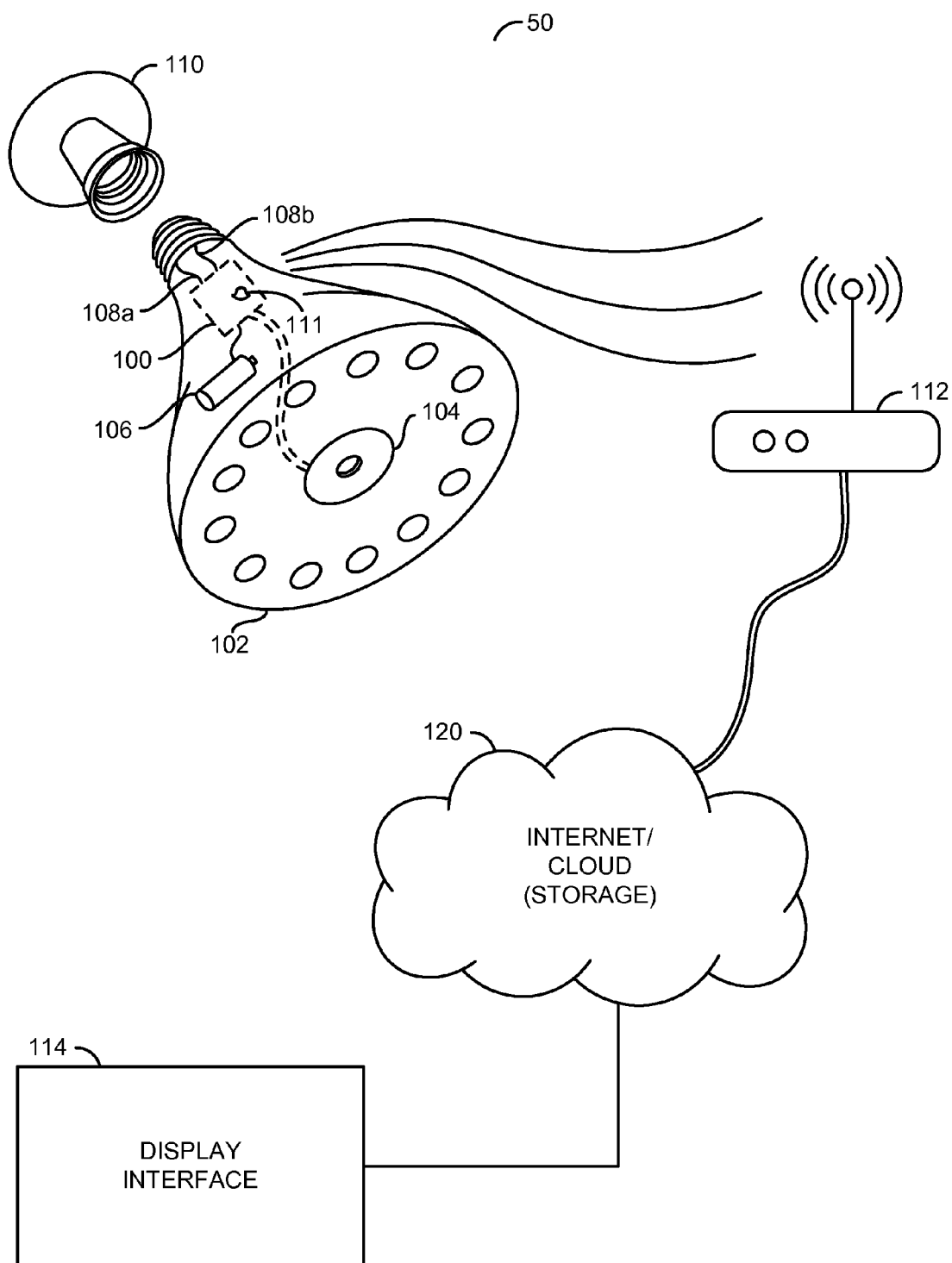


FIG. 1

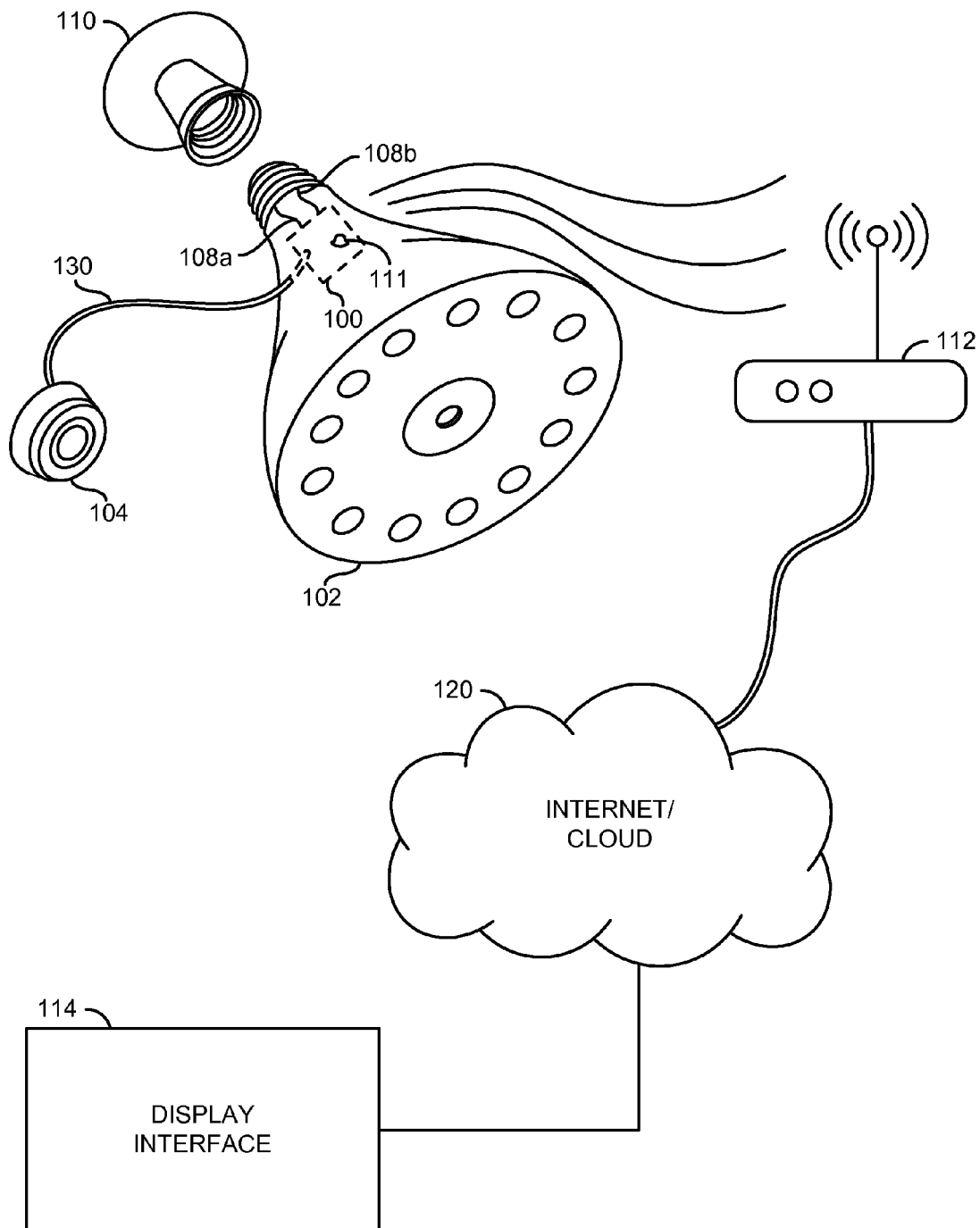


FIG. 2

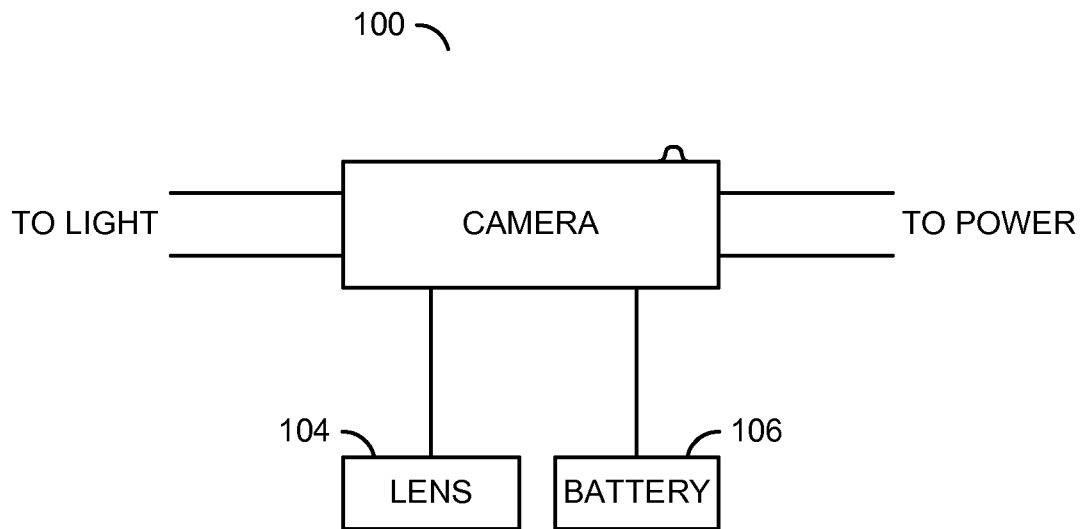


FIG. 3

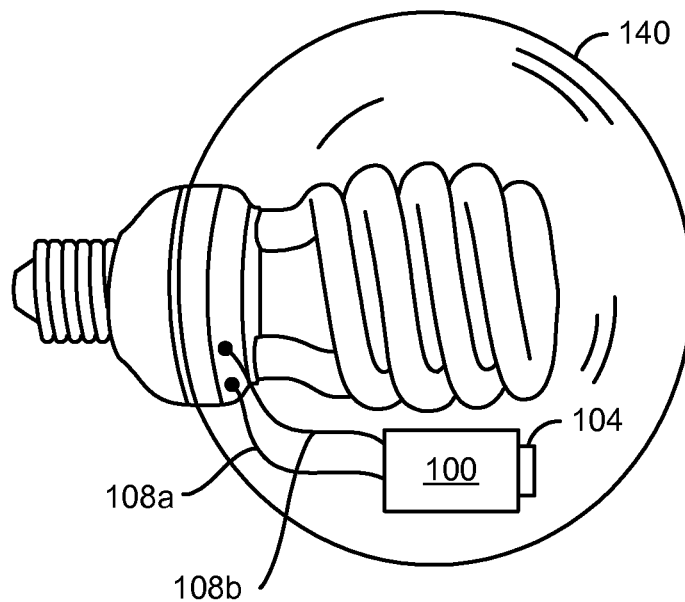


FIG. 4A

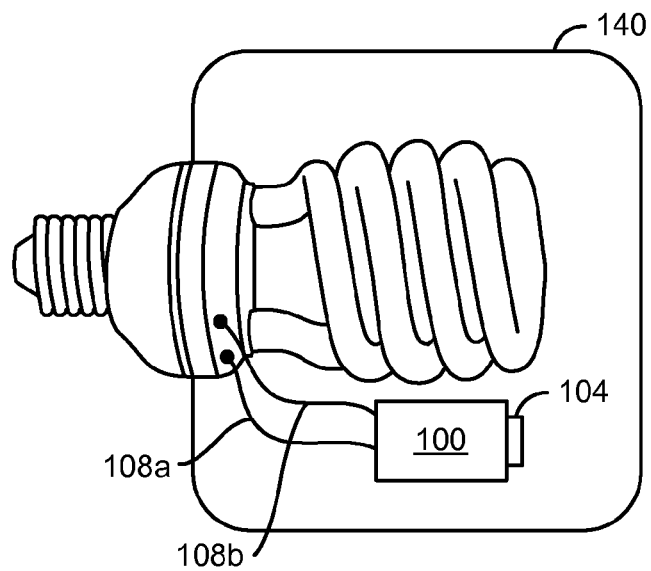


FIG. 4B

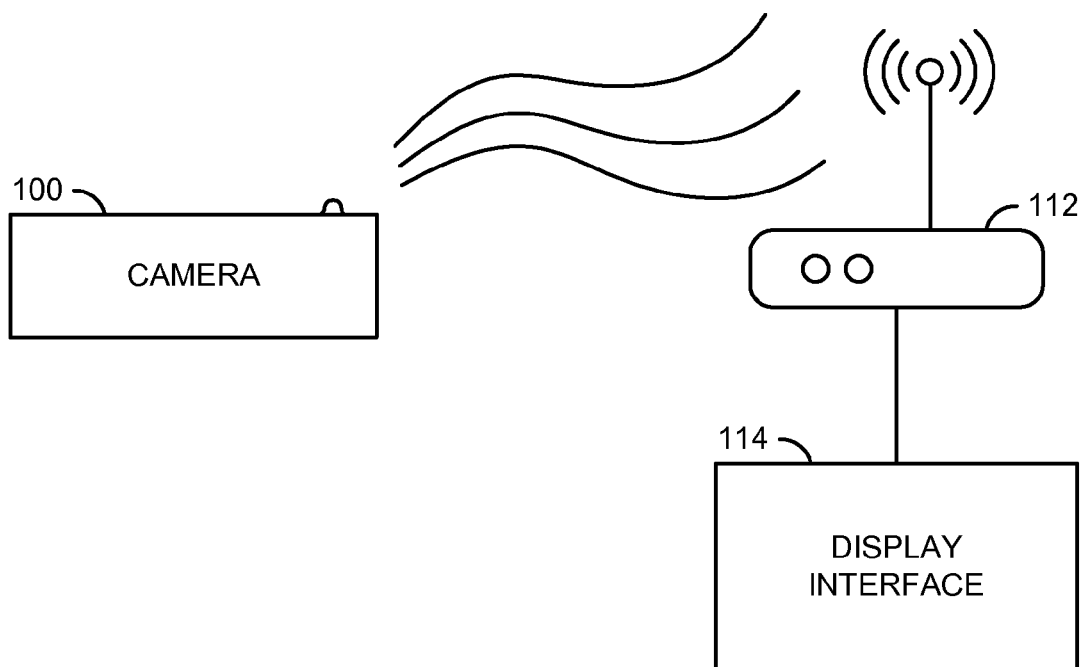


FIG. 5

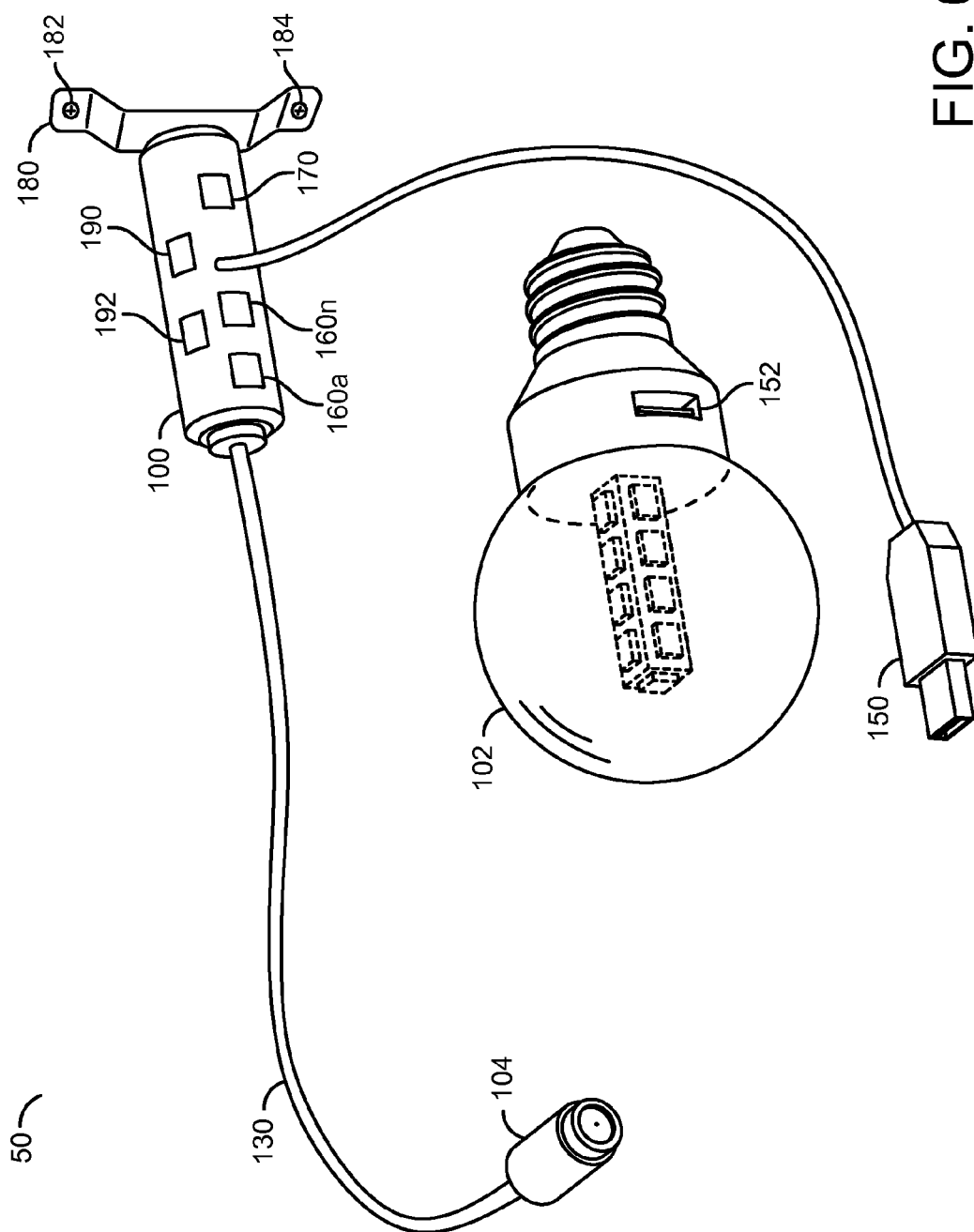


FIG. 6

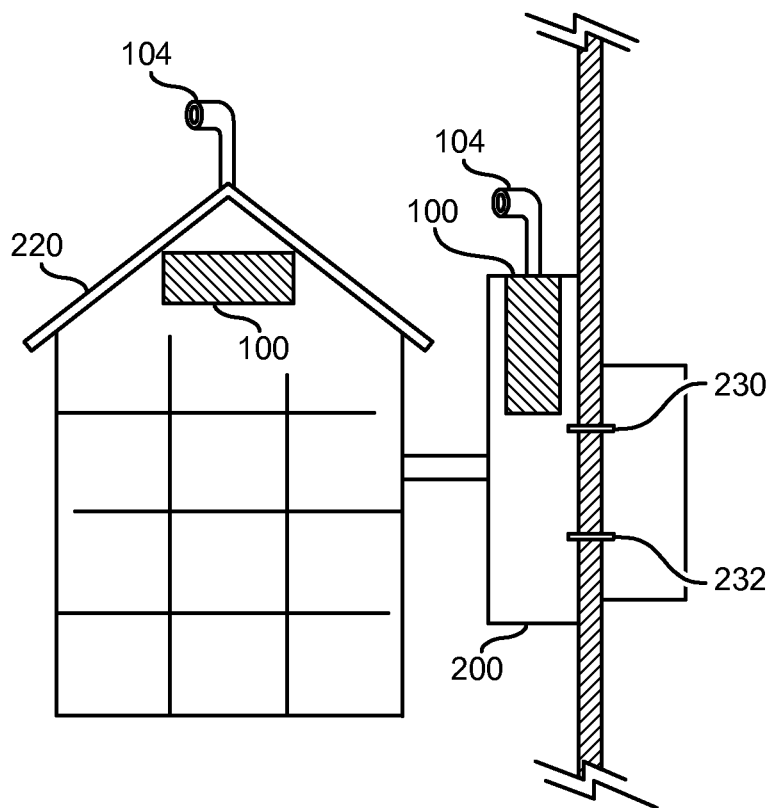


FIG. 7

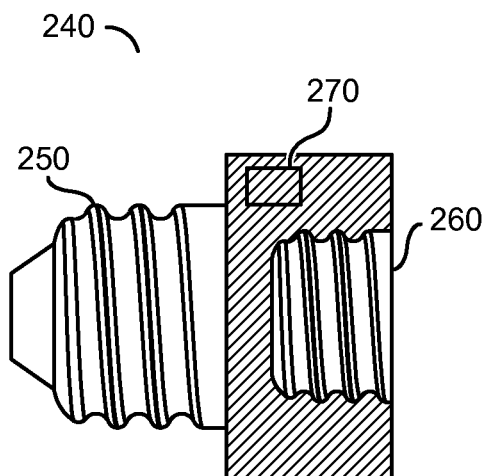


FIG. 8

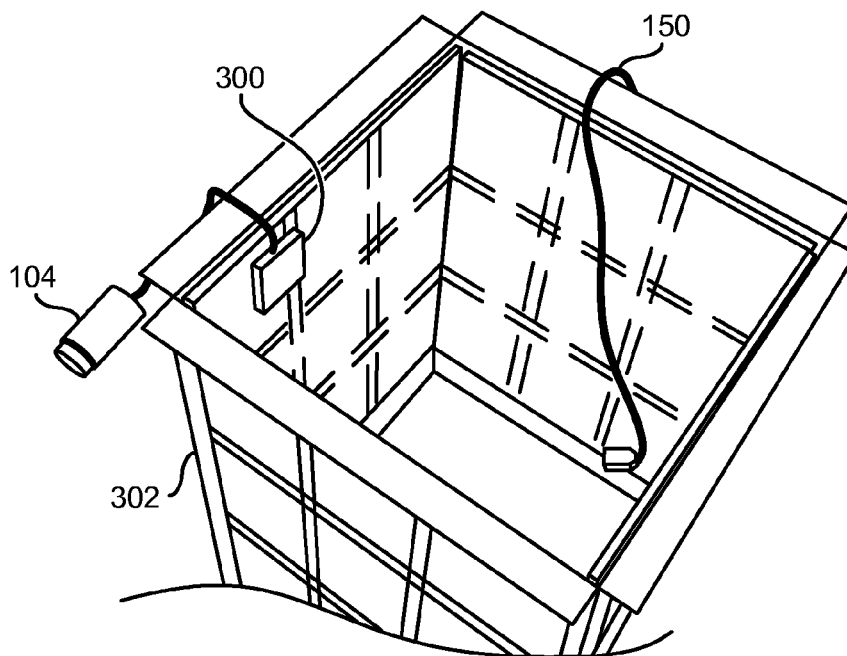


FIG. 9

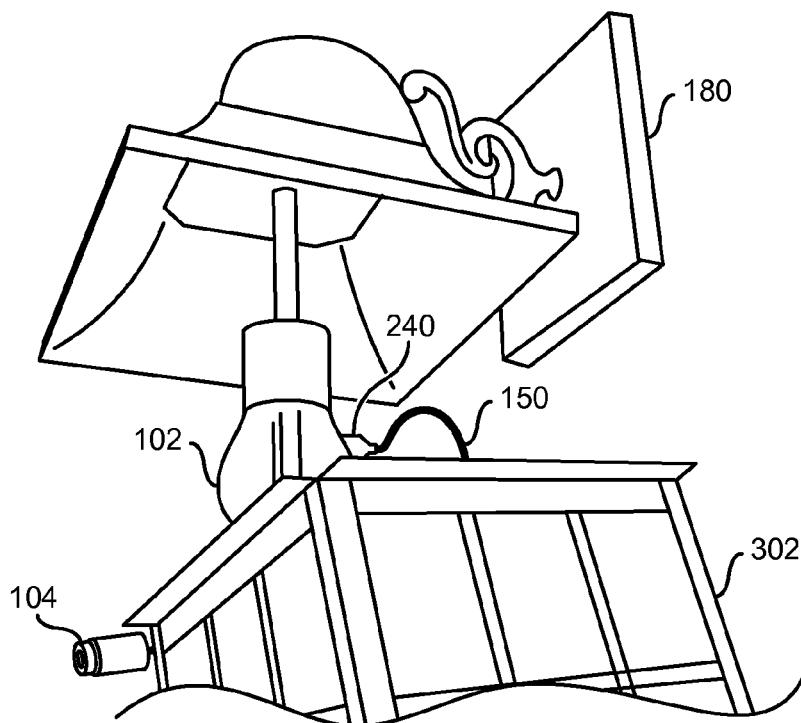


FIG. 10

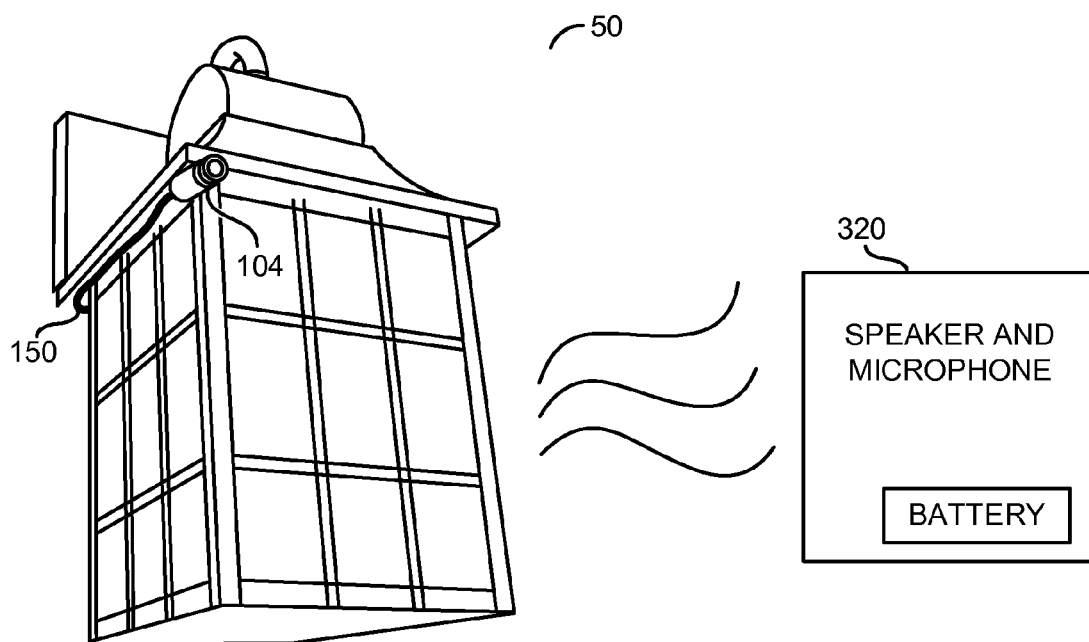


FIG. 11

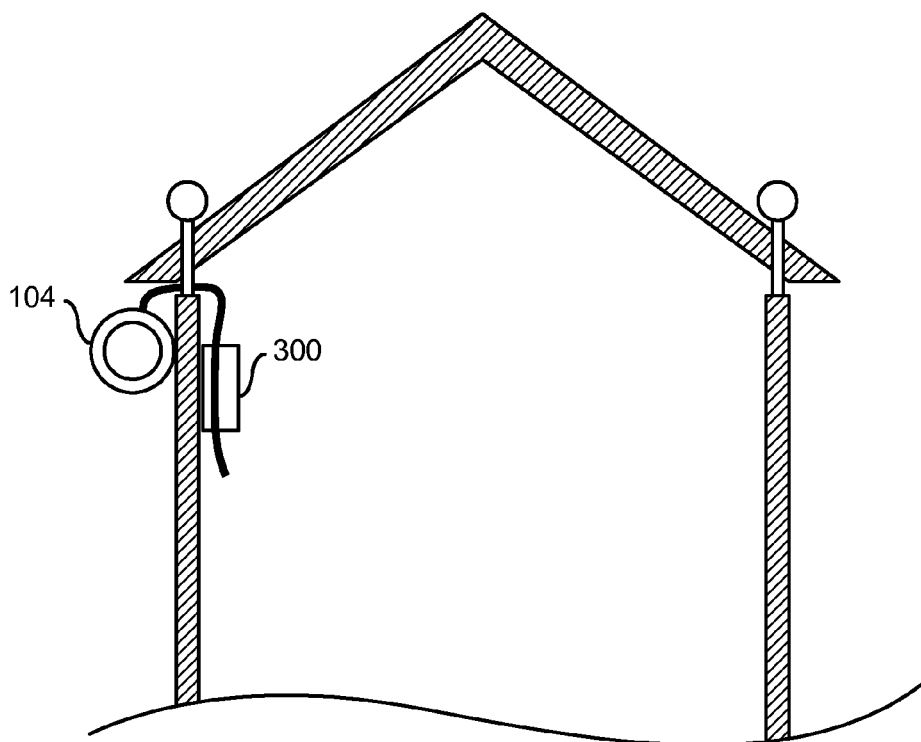


FIG. 12

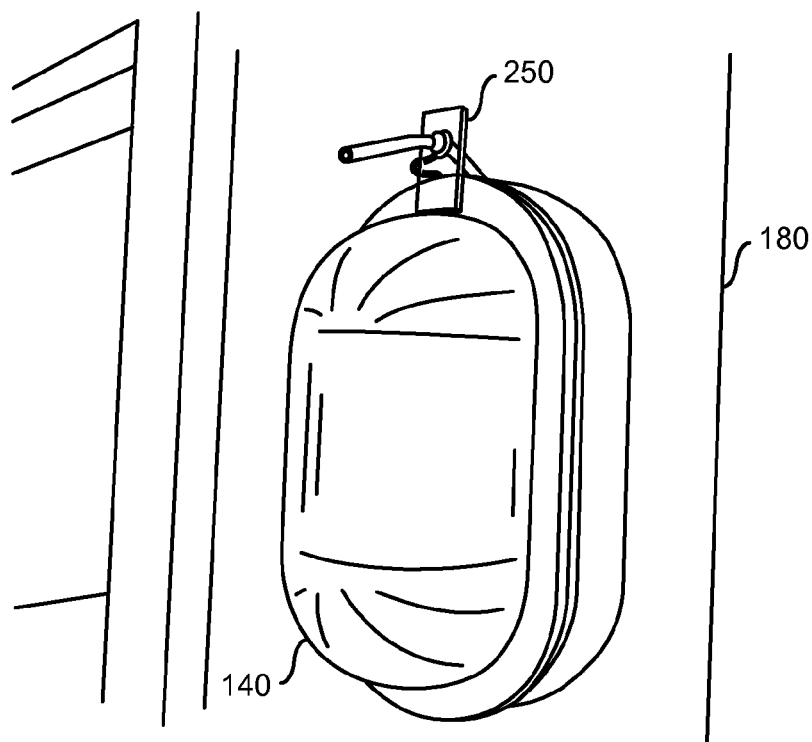


FIG. 13

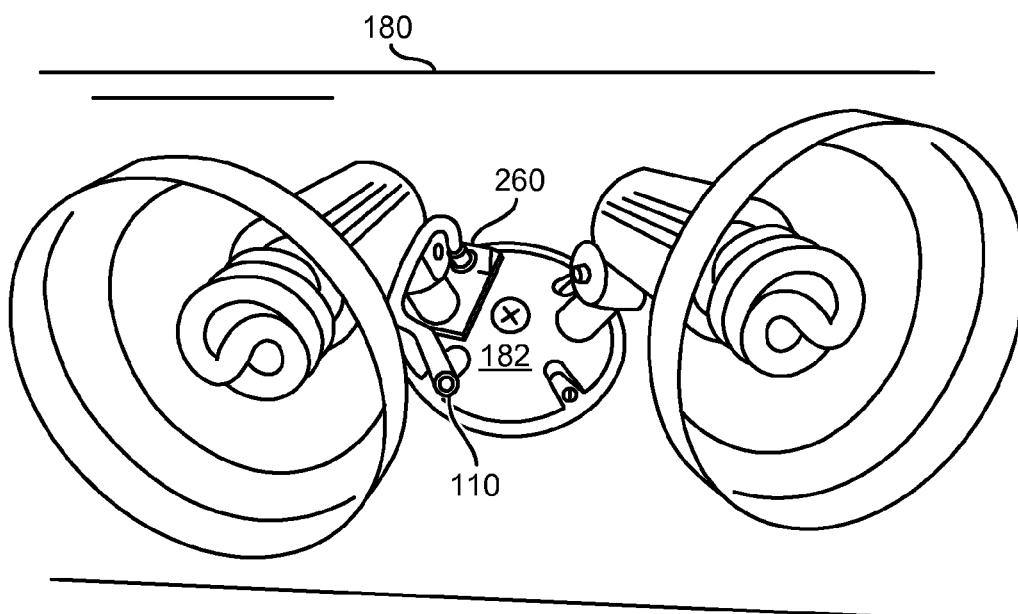


FIG. 14

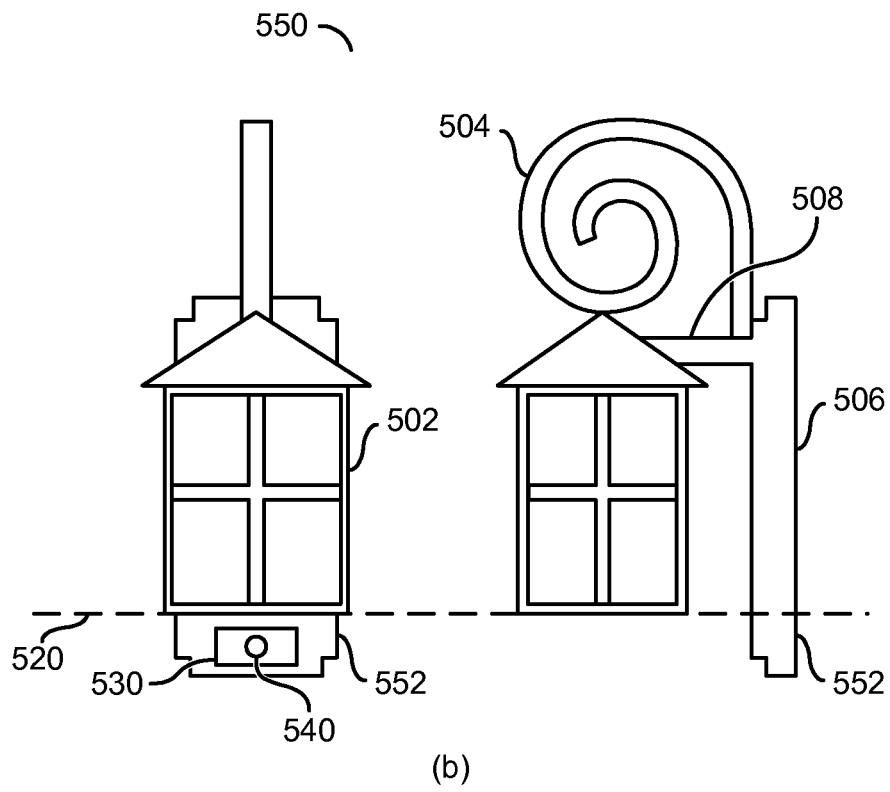
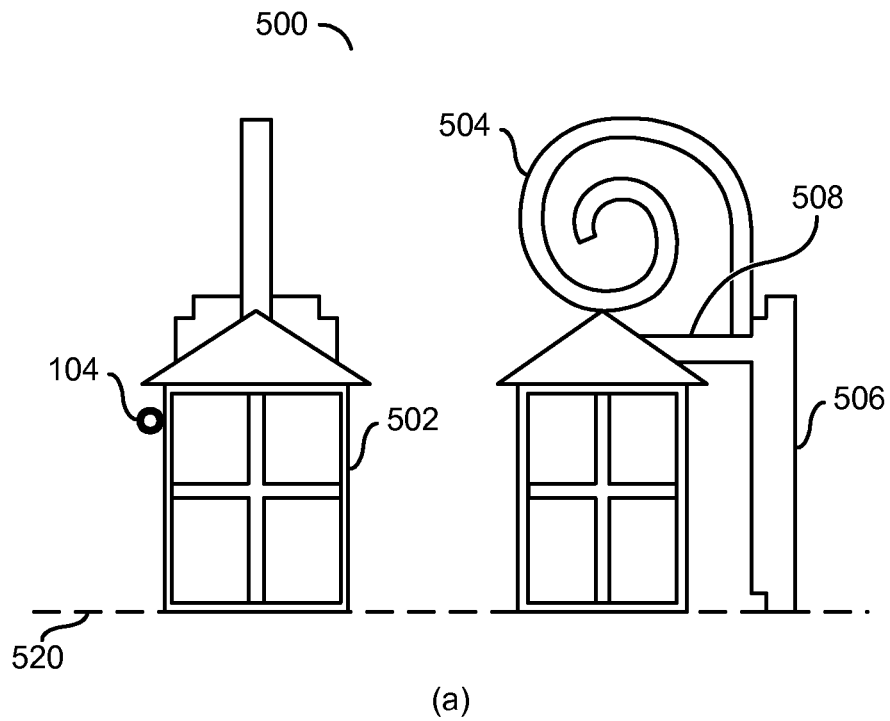


FIG. 15

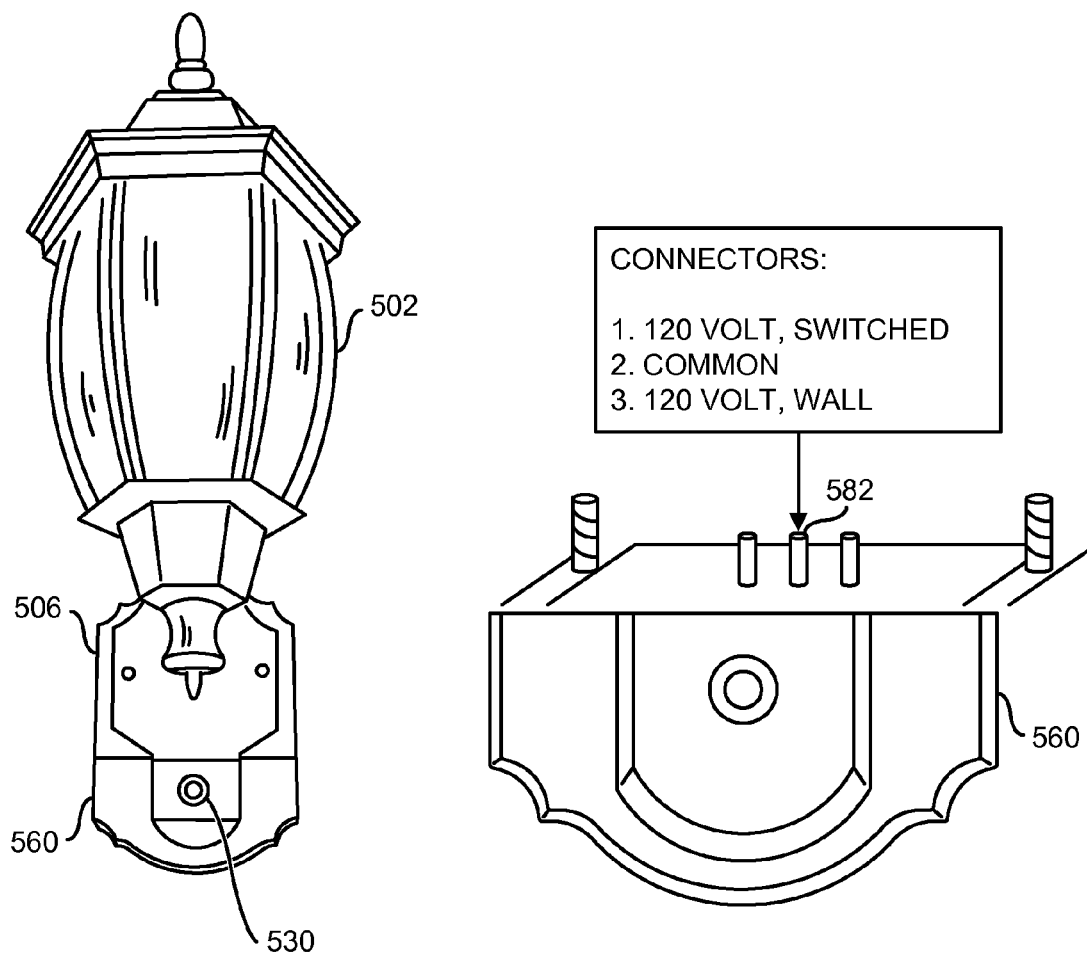


FIG. 16

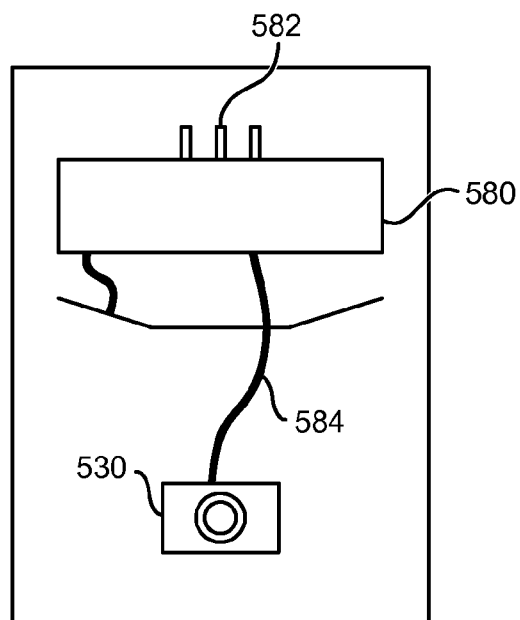


FIG. 17

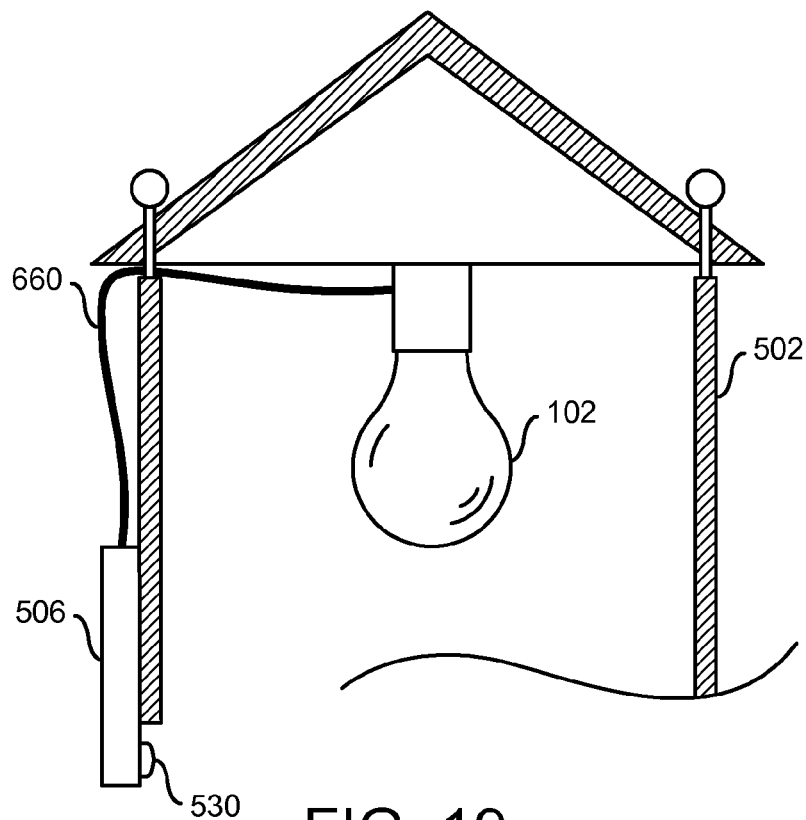
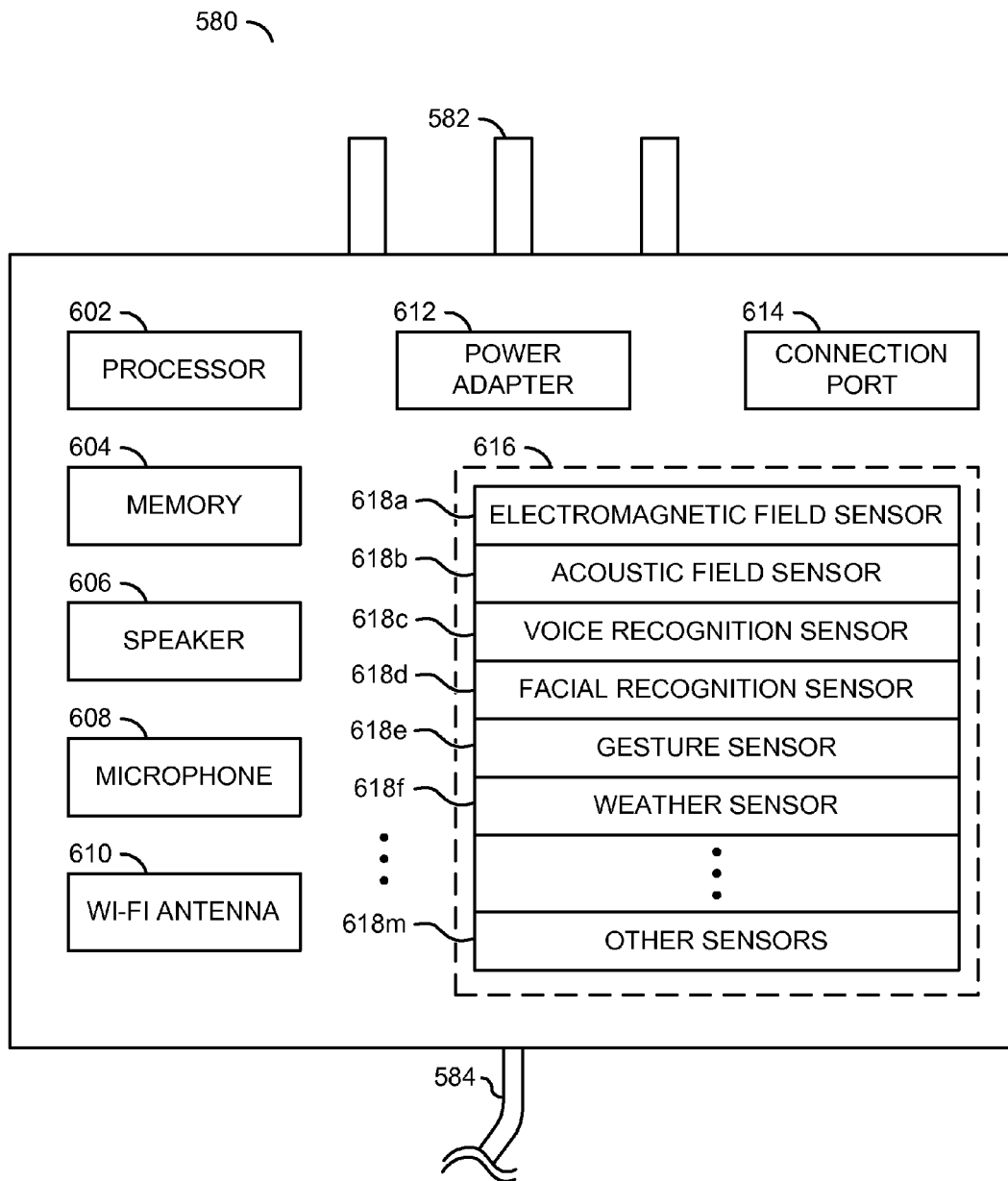


FIG. 19

FIG. 18

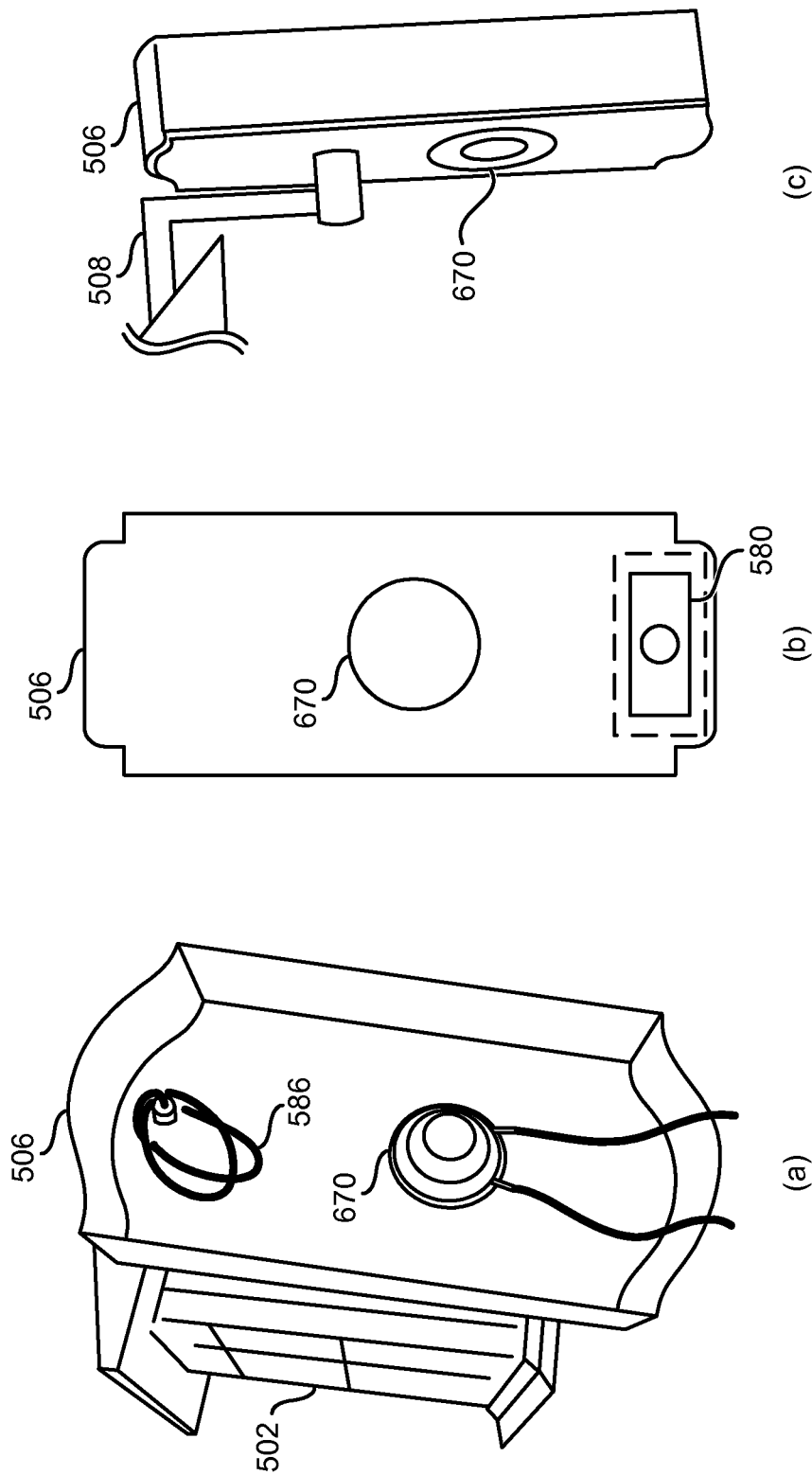


FIG. 20

INTERNET PROTOCOL SECURITY CAMERA CONNECTED LIGHT BULB/SYSTEM

This application relates to U.S. Provisional Application No. 61/923,931, filed Jan. 6, 2014, which relates to U.S. Ser. No. 13/921,597, filed Jun. 19, 2013, which relates to U.S. Provisional Application No. 61/684,310, filed Aug. 17, 2012, U.S. Provisional Application No. 61/783,474, filed Mar. 14, 2013 and U.S. Provisional Application No. 61/790,865, filed Mar. 15, 2013, each of which are hereby incorporated by reference in their entirety.

FIELD OF THE INVENTION

The present invention relates to security cameras generally and, more particularly, to a method and/or apparatus for implementing an Internet Protocol security camera connected light bulb/system.

BACKGROUND OF THE INVENTION

Conventional light bulbs are passive devices with (at most) simple sensors (light or motion) to help turn the light bulb on or off. Basic Wi-Fi connected light bulbs allow users to control a light bulb from Wi-Fi connected devices. Such systems do not have signals from the light bulb to the users to help the users decide how to control the light bulb. Hence, the control functions would be limited to simple algorithms such as time-based on-off and random on-off timings.

Conventional security cameras need to access an electrical outlet for power. Such systems do not provide any solution if there is no electrical outlet. Often times, especially in an outdoor installation, electrical outlets are not available. Adding a new electrical outlet for a residential home or a small business can cost more in time and money than an average cost of security camera hardware.

Disadvantages with conventional systems are significant. A simple light bulb with one way communication cannot be intelligent. Another disadvantage of conventional security cameras is that they do not provide a solution when there is no power outlet.

It would be desirable to implement an IP (internet protocol) security camera connected light bulb/system to provide an intelligent light bulb/system with two way communication of sound and/or images that allow imaginative ways of controlling lighting with security features.

SUMMARY OF THE INVENTION

The present invention concerns an apparatus comprising an antenna module and a control module. The antenna module may be configured to connect and send data to a local network and a mobile handheld device through a wireless connection. The control module may be configured to provide (i) a physical connection to the antenna module, (ii) a power source to an external device, and (iii) a camera sensor to capture still and motion pictures and sounds of a surrounding environment of the apparatus. The pictures may be sent as the data through the wireless connection or through a mobile handheld device.

The objects, features and advantages of the present invention include providing a security camera that may (i) receive power from a socket of an outdoor light, (ii) provide a wireless connection to a computer network, (iii) be cost effective to implement and/or (iv) provide intelligent control to a light bulb/system.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, features and advantages of the present invention will be apparent from the following detailed description and the appended claims and drawings in which:

FIG. 1 is a diagram of an example embodiment of the invention;

FIG. 2 is an alternate diagram of an example of the invention;

FIG. 3 is a more detailed diagram of the camera module;

FIGS. 4A-4B are examples of the camera module including the housing of a lightbulb;

FIG. 5 is a diagram of an alternate implementation of the invention;

FIG. 6 is a diagram of a distributed implementation;

FIG. 7 is a diagram of an example installation;

FIG. 8 is a diagram of an adapter;

FIG. 9 is a diagram showing an example installation in an outdoor light;

FIG. 10 is a more detailed diagram of the installation of FIG. 9;

FIG. 11 is a diagram illustrating an outdoor light with the invention installed;

FIG. 12 is a diagram showing an installation on a typical house;

FIG. 13 is a diagram illustrating a side mount installation;

FIG. 14 is a diagram illustrating an installation with a flood light;

FIG. 15 is a diagram illustrating an installation of a universal fixture base configuration for a light;

FIG. 16 is a diagram illustrating a modular design of a universal fixture base configuration for a light;

FIG. 17 is a diagram illustrating a processor sub-module connected to a lens sub-module;

FIG. 18, is a diagram illustrating a processor sub-module;

FIG. 19 is a diagram illustrating a processor sub-module and lens sub-module connected to a light fixture; and

FIG. 20 is a diagram illustrating an example of a speaker separated from the processor sub-module.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a block diagram of a system 50 is shown in accordance with a preferred embodiment of the present invention. The system 50 generally comprises a camera module and sensor (with or without a lens) 100, a bulb 102, a lens module 104, an optional battery 106 (since DC power is provided from the light bulb), a number of detachable power and/or control wires 108a-108b, a bendable and rigid pipe (to provide structural support of 100 and 104), a light bulb socket for all popular bases 110, an antenna 111, a Wi-Fi adapter/router 112, a phone, tablet, PC, or TV display interface 114, and a cloud storage and/or computation/analytic of images 120. The cloud storage 120 may be the Internet, a local area network, a Network Attached Storage (NAS) device, etc.

The connection between the lens sensor 104 and the camera 100 may be implemented as a number of wires (a standard interface for lens module to cell phone circuitry) that may run at high bandwidth, and usually very short distances (FIG. 3). The wires may be implemented in the same chassis as the camera 100. A speaker and/or microphone may be included in the lens 104. The camera 100 and/or lens 104 may be outside of a light shade 140 (FIGS. 4A-4B) if the shade 140 is opaque.

The camera module 100 may include a complete camera (e.g., without battery and display), but with the video cir-

cuitry, the antenna **111**, a speaker and/or a microphone. The camera **100** may minimize manufacturing costs by maximizing the amount of circuitry that fits in the camera module **100**. The camera **100** may fit in several different mounting configurations (e.g., with and without light bulb integration).

A number of configurations may be implemented (e.g., the circuit **100** being mounted inside the light bulb **102** and/or outside the light bulb **102**). In one example, the camera circuit **100** may be mounted inside the light bulb **102** as a small circuit board. Circuitry inside the light bulb **102** may be used to control the intensity and/or color of the bulb **102**. The camera circuit **100** may process either still pictures or video or sound captured from the lens **104**.

The antenna **111** may be designed to fit inside the camera module **100**. The antenna **111** may be implemented as a Wi-Fi antenna. In one example, a GoPro Wi-Fi backpack may be implemented, which is normally about 2 inches wide. In one example, the Wi-Fi frequency may be 2.5 Ghz, With $\frac{1}{4}$ wavelength of around 31 mm (e.g., 1.2 inches). A standard inexpensive omni-directional antenna **111** may be as simple as a wire of a 1.2 inch length and that may fit inside a small (e.g., a 1.5 inch diameter) camera module **100**. To optimize the antenna **111** with higher gain, a cable (e.g., more than 3 inches) may be included as the antenna **111**.

The control signals from the camera **100** to the light bulb **102** may include ON/OFF, intensity and/or color control. In one example, an array of LED lights may be implemented to provide changes in intensity and/or color. An array may be used to generate specific colors (e.g., white). Other colors may be implemented to meet the design criteria of a particular implementation.

In FIG. 5, an example is shown where the camera **100** and the light bulb **102** are controlled by users without going through the cloud **120**. A smartphone or tablet application may control the camera **100** and/or the light bulb **102**, via Wi-Fi, bluetooth, etc. In one example, a voice command (or hand clapping) may be used to control the camera **100** and/or the light bulb **102** (although not likely for outdoor). In another example, a separate remote control may be implemented (e.g., Wi-Fi, bluetooth, IR, etc.).

The Wi-Fi antenna **111** may be included inside the camera **100**, similar to other Wi-Fi connected devices. A very small Wi-Fi connected HID camera module (e.g., with a 1.5 inch diameter and 0.75 inch thickness) may attach to many different sockets/mounts for different uses and/or models. The light fixture **110** is just one of several mounts.

In one example, a cable **130** (see FIG. 2) may range from zero length (stealth, likely in front of the light bulb to avoid glare), to as much as 12 inches (or more) for positioning and/or aiming of the lens **104**. The cable **130** may provide power, ground, and a control signal to turn the light bulb **102** on/off and change intensity and/or color. The lens **104** and/or the camera **100** may include all or part of the electronics needed. The particular camera features implemented in the lens **104** and/or the camera module **100** may be varied to meet the design criteria of a particular implementation. The cable **130** should be rigid and/or bendable.

In one example, the socket **110** may have 5 or more cable sockets (e.g., 4 sides and 1 at the front). The cable **130** may be removable from the bulb **102** and/or the camera **100**. The cable **130** may be removable such that different lengths may be substituted to meet the design criteria of a particular implementation.

The camera **100** may be configured to take control of one or more of a number of light bulbs connected to a common power switch on the wall. A typical front door of a house usually has one or two light fixtures. Indoor lights often have

multiple light bulbs controlled by one wall switch, especially ceiling lights. To control the other light bulbs without a camera, Wi-Fi connected light bulbs may be implemented. The wall switch controlling the receptacle is normally left "on" to power the electronics in the bulbs **102** and/or the camera **100**.

The receptacle **110** may be varied to meet the design criteria of a particular implementation. The receptacle **110** may be designed to cover a variety of popular light bulb configurations with different bases (e.g., an A19 is the most popular). The system **50** may operate with LED bulbs and/or Compact Florescent bulbs and/or other types of bulbs (e.g., HID, etc.). The system **50** may operate with a high quality speaker (e.g., a 1.5 inch diameter) and/or a microphone module that may attach to or be integrated to the back of the camera **100**.

The system **50** may be used to control an advanced light bulb (e.g., LED, CFL, etc.) by a miniature security camera circuit **100**. The control functions may be automated by the signals received by the camera **100**, or may be controlled manually by users with access to the images and/or sounds from the camera **100**. A variety of Internet connected devices (such smart phones) may be used to control the system **50**. The system **50** may provide an immediate benefit of providing electrical power to the camera **100** through the existing light fixture **110** where the light bulb **102** would fit. The additional benefits of controlling a light bulb **102** with images and/or sound from the camera **100** may become important as users learn about the possibilities.

The system **50** may solve several problems by integrating an advanced light bulb **102** (LED, CFC, etc.) with an advanced and/or miniature security camera **100**. One problem solved is to provide true intelligence to a light bulb **102** when approached by a person and/or an animal. The light fixture **110** (e.g., in a residential home) is usually placed where strangers and/or animals will likely visit. When a stranger and/or an animal is detected by the security camera **100**, an alert may be sent to the home owner. The home owner may instruct the light bulb **102** to operate in a friendly manner (e.g., low intensity and/or rhythmic) or in a hostile manner (e.g., high intensity and/or dissonant). In addition, a microphone and/or speaker of the security camera **100** may allow a home owner to enhance the communication through voice and/or sound. Another problem that the system **50** may solve is that the light fixture **110** can provide power to the security camera through the integrated light bulb. In outdoor residential environment, there is usually no power outlet and/or home-owners generally do not like to run external power cords over the house walls.

In one example, all of the signals from a Wi-Fi connected light bulb and/or an Internet controlled security camera may be controlled by a PC or a web-service in the cloud or a web-based (or portable) computing device. For example, a PC software program may be used to control both the light bulb **102** and/or the security camera **100**. In one example, such PC software may include a facial recognition module. Such a facial recognition module may be used to identify and/or sort out friendly people and/or animals from unfriendly people and/or animals. Friendly people may trigger certain sounds, while unfriendly people may trigger other sounds. In one example, an RFID detector module may be included on the camera module **100**. Such an RFID detector module may identify whether a particular person is carrying an RFID transmitter that is identifiable by the camera **100**. In such a case, an identified person may be presented with familiar lighting sounds. An unidentified person may receive unfriendly sounds (e.g., an alarm, etc.).

In one example, the camera module **100** may include storage for pre-recorded voice messages and/or music for play-

back that may depend on the particular image/sound/voice input received. For example, unwanted animals (e.g., raccoon, gofer, herons, etc.) may be detected and may be scared away by human voice or other predator voice. Other animals, like hummingbirds and/or squirrels, may be attracted by mating sounds. Another example may be a voice instruction for delivery personnel at front doors. In one example, such pre-recorded messages may be updated from the cloud storage **120** via internet connection. Such images/sounds input may be processed and/or matched with images in the cloud-service and/or analysis may generate appropriate voice messages or music for playback. The latency in response must be minimized and managed. Such messages may be real time (live) from the user watching the image through internet connection. Such voice/music output may be replaced or combined by the algorithm/instruction to control the LED array intensity and/or color of the same light fixture.

The system **50**, with the camera module **100**, may support conventional landscaping lighting fixtures (e.g., 12 volt DC light bulbs). The circuitry may be simpler if dedicated to a landscaping low voltage DC lighting fixture rather than to a traditional AC voltage. Alternatively, the circuitry may be made to support both traditional AC voltage (120 volt) and/or low voltage DC such as 12 volt.

In outdoor settings when there is no wireless internet network, the system **50** may use the camera **100** to control a light bulb, but may work with "ad hoc Wi-Fi network" supported by the camera and/or a hand-held device, such as a smartphone, tablet, etc. A sample usage model is to install an IP security camera with light bulb control in a place where there is no wireless Internet network, and if needed, also install Wi-Fi controlled light bulbs that are connected to the same power switch. A user may then control the camera and the light bulbs with a hand-held device via ad hoc Wi-Fi or bluetooth wireless connection. The camera **100**, with instruction from a user, may then proceed to control the light bulb **102** for visitors and/or visiting animals. An image captured by the camera **100** may be downloaded directly to a hand-held device which may later upload to the cloud storage **120**. Alternatively, removable storage in the camera (e.g., memory cards) may be removed and inserted into a computer to upload the recorded content to the cloud storage **120**.

The system **50** may provide two way communication circuitry in a light bulb, and/or power and/or signals from a light bulb to a miniaturized security camera. Application software may provide intelligence to a light bulb. Innovative placements of the camera **100** with respect to a high intensity light bulb in a closed environment may be used to avoid glare and/or provide optimal lighting to the camera **100**.

The system **50** may provide value in the home security camera market. About half of the DIY (Do It Yourself) security camera market does not have an easy way to connect to a power outlet. The system **50** may save homeowners easily \$200 in value by simplifying the installation process. The DIY security camera market is about 3 million units per year in the US and is predicted to grow to about 12 million units per year by 2016. With the system **50**, about half of such units can save \$200 per unit in installation cost, which translates to about \$300 M in 2012 and \$1.2 B in 2016.

The system **50** may also provide intelligence (e.g., communication, etc.) in the light bulb **102**. The system **50** may allow users to communicate to strangers and/or animals in a creative way by combining lighting and/or sound with two-way signals.

Various electronics and/or capabilities may be included in the light fixture **110** adapter instead of in the light bulb **102**. The advantage of such an installation is the compatibility with

all types of light bulbs (e.g., LED light bulbs, etc.). The adapter **110** may provide a) DC voltage (e.g., 5 volts) for the camera and/or b) wireless communication (e.g., Wi-Fi, RF, etc.) and/or c) dimmer control circuitry.

The camera **100** may integrate various communication channels in hardware and/or software to provide various base-station capabilities of a security monitoring system. For example, Wi-Fi communication to a Wi-Fi router may enable communication with the Internet. In another example, an ad-hoc Wi-Fi communication with similar cameras or monitoring devices may be implemented. RF transceivers (e.g., FM channels around 315 MHZ, 433 MHZ, etc.) may be implemented to communicate with other monitoring devices such as smoke detectors, water sensors, thermostats, carbon-monoxide detectors, PIR motion detectors, key pads, sirens, etc. Cellular circuitry may be used to communicate with external cell towers. The cellular circuitry may enable communication with central security monitoring services and/or the Internet, as well as a backup channel if the Wi-Fi communication fails. A landline telephone communication channel may be implemented. A landline may enable low cost and/or redundant communication with a central security monitoring service.

Referring to FIG. 6, an example of the system **50** in a distributed configuration is shown. The lens-sensor module **104**, the processor module **100** and/or audio elements may be separated (or distributed) to make the system **50** smaller and/or more streamlined. The sensor module **104** and/or the processor module **100** may be integrated via a high speed connection such as a micro-coaxial cable. The audio component(s) may be integrated via wireless communication (e.g., RF, etc.). In one example, the processor module **100** may be powered through a connector **150** that may be plugged into a receptacle **152**. In one example, the connector **150** and/or the receptacle **152** may be implemented as Universal Serial Bus (USB) connectors. However, other types of general purpose connectors may be implemented.

The system **50** may augment vision with one or more sensors **160a-160n** (e.g., IR, PIR, sonar, audio detection, doorbell sound, and/or doorbell signal) to improve the detection of a person. The sensors **160a-160n** may be placed in the housing of the processor module **100** along with a speaker **170**. Other modules may be placed nearby. The performance of the system **50** may be improved by placing the sensors **160a-160n** in positions with better angles and/or by implementing more of the sensors **160a-160n** to provide inputs to the processor module **100**.

The camera/processor module **100** may include a bracket **180** to attach to a light fixture **110** via a mounting screw connecting the system **50** to the wall mounting fixture. A threaded neck of a security light may be connected to the wall mounting fixture **180**. A removable nut at the top of a light fixture **110** may be implemented where the camera module **100** is connected to the light bulb **102** for power and/or control.

The system **50** may control the activation of security deterrence by implementing (i) harsh flashing of the light bulb **102**, (ii) a loud siren, (iii) pepper spray, (iv) tear gas, or (v) other deterring actions and/or sounds. In one example, an automatic announcement may be implemented to deter tampering and/or theft of the system **50** by detecting close proximity of a person (e.g., a predetermined range, such as 2 feet, etc.). For example, a sample announcement such as "Do not tamper with this camera. Your pictures have been stored and may be uploaded to the appropriate authority" may be implemented.

In one example, an automatic announcement when a visitor is detected by the system **50** may be made. The announcement

may provide time for the homeowner and/or trusted neighbors/friends to answer a phone call placed by the system 50. An example of such an announcement may be, "Hi, how can we help you? We are home but not expecting a visitor at this time."

In one example, the gooseneck camera 130 may be mounted to one of the mounting screws 182 and/or 184 of the light fixture 110. Such wall mounting screws are normally standard in most fixtures in the United States. The sensor module 104 may be mounted in the front. The sensor module 104 may be as small as 0.5 inches in diameter for HD video. For example, an implementation such as an "endoscopy inspection camera" may be used.

The processor module 100 may be located at the mounting end of a housing with the mounting screws 182 and/or 184 by using a micro-coax cable. In one example, the processor module 100 may be stored together with the sensor module 104 in the front in a large housing (e.g., 1.5 inch diameter, etc.). The interconnect to the light bulb 102 may be another wire that runs underneath the cap of the light fixture 110. Another configuration is to attach the processor module 100 at the back of the light fixture 110. If the processor 100 is mounted inside the light fixture 110, the need to separate out a Wi-Fi antenna 190 and/or keep the antenna 190 outside to avoid shielding problems from the light fixture may be minimized.

In one example, a selection of background sounds made by a strong human voice may be mixed in with the voice of the homeowner or trusted neighbors/friends when answering the phone call placed by the camera. Such background voices and/or noises may provide a deterring effect by appearing to a potential intruder that several people are home.

Referring to FIG. 7, the system 50 is shown with the lens/sensor/processor 100 integrated into the light fixture 110 during manufacturing of the light fixture. FIG. 7 shows two different ways to integrate the apparatus 50 into a light fixture. The first implementation integrates into the light fixture wall mount base. The second implementation integrates inside the light fixture (e.g., on the top or somewhere in the bottom part of the light fixture). The lens/sensor module 100 generally needs some way to pass signals from the enclosure, which may be done with the telescoping gooseneck connection 130 that may support high speed interconnect to the control module 100. A Wi-Fi antenna may also be placed outside the enclosure for optimal range of communication. In addition, the audio speaker and/or microphone may be integrated in the light fixture or as a separate module.

An industrial design of the camera module 100 may be improved using such an integration process. For example, the speaker 170 and/or a microphone 192 may be separated as an option since the light fixture 110 is often mounted too high for two way intercom communication. In one example, two-way voice communication may be connected to the processor module 100 through wireless communication such as RF signals. Such two-way voice intercom may be placed close to a doorbell.

The apparatus 50 may include the camera control module 100, the camera lens/sensor 104, and an audio speaker/microphone intercom. The camera control module 100 may be located in a wall-mounted base 200. In an alternate embodiment, the control module 100 may be located in the roof of a building 220. The camera/lens sensor module 100 may be connected to the control module 100 with a telescopic gooseneck connector, typically through a high speed interconnect. The audio speaker/microphone intercom may be integrated into a light fixture, or may be implemented as a separate

intercom module with the wireless communication. The system also includes securing brackets 230 and 232.

Referring to FIG. 8, a DC power and control implementation is shown. FIG. 8 shows an adapter 240 that shows one end implemented as a standard A19 screw thread for the standard E26/E27 base socket. The other end is a smaller base, like E10 or E5. The adapter 240 provides a place to mount the electronics, DC power source and/or wireless communication interface. The adapter 240 may be implemented in a compact fashion. The adapter 240 may allow the apparatus 50 to be used with standard light bulbs and to be implemented at a lower cost. The adapter 240 may support E5 to E27, as well as new bases (e.g., a GU24 base, etc.).

A screw end 250 may be compatible with an A19 type standard bulb fixture. A base 260 may be implemented to accept a smaller, more modern type of bulb, such as an E26/E27, or an E10 or E5 type fixture. A cavity 270 may be implemented to store the electronics module 100, a DC low voltage power supply, and/or a wireless communications module, etc.

The audio signal may be wirelessly transmitted to a separate audio intercom. In one example, a speaker and/or a microphone may be optionally powered by a battery. Such a configuration may be desirable to allow optimal placement of an audio communication and video recording and sensing.

Referring to FIGS. 9 and 10, an example mounting of the apparatus 50 in an outdoor light is shown. A connection piece 300 is shown. The connection piece 300 may be implemented, in one example, as an adhesive. In another example, the connection piece 300 may be a hook and loop fastener.

FIGS. 9, 10, and 12 show various novel and effective ways to mount the camera apparatus 50 to an existing outdoor light fixture 302. FIG. 9 shows using a hook and loop fastener 300 to tie the clamp to the side of the light fixture 302. FIG. 10 shows how a power/control connector 150 is inserted into a LED light bulb using an adapter (e.g., as in FIG. 8). A typical implementation of the connector 150 may be implemented as a mini-USB connector. FIG. 12 shows how the hook and loop connectors 300 may be clamped by the lighting fixture 302 to securely mount the camera 100 to the light fixture 302. The clamping action is novel and effective. The light fixture 302 may screw or clamp down the loose ties from the camera apparatus 100.

Referring to FIG. 11, a wireless speaker and microphone implementation is shown. A module 320 may wirelessly connect to the module 100. By implementing a wireless module 320 for the intercom, additional placement flexibility may result. FIG. 11 shows a desirable configuration to allow optimal placements of audio communication and video recording/sensing. The example in FIG. 11 shows an indoor video camera configured to look outside of a house through a window (e.g., through the lens sensor 104), and/or wirelessly communicate with a separate outdoor audio intercom powered by batteries. Such an embodiment shows an indoor video and outdoor audio intercom.

Referring to FIG. 12, an alternate installation is shown. A light fixture may screw or clamp down the ties from the camera apparatus by using simple adhesives for easy mounting. For example, the camera module 100 may include a glue tape (e.g., 3M, Scotch, etc.) to attach the light fixture 110 and/or the system 50 to a wall. A connection to the light bulb 102 (or the adapter 240) may be used for power and/or control. The system 50 may be used to control the light bulb 102 in order to eliminate the need for an independent IR light source in the camera during night time by (i) automatically turning on or increasing light intensity of the light bulb 102 when there is insufficient lighting for the camera module 100

to perform, and/or (ii) having an IR light source in the light bulb **102** of the light fixture **110**.

The light fixture may screw into a clamp down bracket. A thin tie down may be used to secure a camera. In one example, a velcro-like tie down may be used. Such an implementation is useful when an LED light is integrated into the light fixture **110** and there will be no availability for a replacement of the bulb **102**. In addition to the light bulb **102** and/or the light fixture **110**, in one example, a separate two-way intercom (speaker and microphone) communicating to the video camera via wireless communication, such as RF or Wi-Fi, may be implemented. Such an implementation may be useful in crime prevention, such as burglaries. The system **50** may be mounted high up under the eaves or with the light fixture, whereas the two-way intercom module may be located at head level and/or near a doorbell.

Referring to FIG. **13**, a side mount installation is shown. In a flush mounted light fixture, one of the fixture mounting screws may be used to anchor a bracket **250** that may be used to connect the gooseneck camera too.

Referring to FIG. **14**, a flood light type installation is shown. In a spotlight installation, most spotlights have a nut that may be used to position a bracket **260**. The bracket **260** may allow positioning of the camera.

Referring to FIG. **15**, an installation of a universal fixture base is shown. A configuration **500** is shown with a wall-mounted base (similar to the configuration described in FIG. **11** shown in FIG. **15(a)**). The configuration **500** may contain the lens sensor **104** at the top of a light fixture **502**. The configuration **500** may have a decorative attachment **504**, a housing **506**, and an attachment **508**. The attachment **504** and/or **508** may provide a physical mount for the light fixture **502**. The attachment **508** may connect the housing **506** to the light fixture **502**. The attachment **508** may provide a channel to hold electrical wires used to power the configuration **500**. The light fixture **502** and the housing **506** are shown generally above a base line **520**. A configuration **550** is shown in FIG. **15(b)**. The configuration **550** may implement a universal base. The configuration **550** adds a housing extension **552**. The housing extension **552** may extend the housing **506** below the base line **520**. The housing extension **552** may contain a lens sub-module **530**. The module **530** may contain a lens sensor **540**. The configuration **550** may provide an improved viewing angle for the lens sensor **540**. For example, when compared with the sensor **104**, the configuration **550** may eliminate the cable **130** (shown in FIG. **2**). For example, a shorter ribbon cable may be used. The sensor **540** and the ribbon cable may be protected from intruders by being enclosed in the housing extension **552** and/or the attachment **508**.

Referring to FIG. **16**, a modular design of a universal fixture base configuration is shown. A modular universal base **560** may be connected to the housing **506** and may be connected or disconnected without removing the light fixture **502** and/or the housing **506** from a wall. The modular universal base **560** may contain the lens sub-module **530** and a processor sub-module to be described in more detail in connection with FIG. **17**. The lens sub-module **530** is shown attached to the modular universal base **560**. However, the sub-module **530** may be separately mounted to allow different viewing angles as desired by the user. The processor sub-module **580** may provide a plug **582** to enable the processor sub-module to control the light bulb **102** (shown in FIG. **1**). The plug **582** is shown as a 3-pronged plug that may provide a switched 120V power source to the light fixture **502**. Other plug variations may be implemented to meet the design criteria of a particular implementation.

Referring to FIG. **17**, a processor sub-module **580** connected to a lens sub-module **530** is shown. The processor sub-module **580** and the lens sub-module **530** may be connected with a cable **584**. Separating the processor sub-module **580** and the lens sub-module **530** may allow the modules to easily attach to various light fixture styles. The processor sub-module **580** may fit inside the housing **506**, the housing extension **552**, and/or the modular universal base **560** and connect to the light fixture **502** and/or housing **506** with the plug **582**. The processor sub-module **580** may be implemented as a flexible plate and/or may have speakers, a microphone, an antenna, and/or a USB and/or other connector for a PC connection and/or Wi-Fi setup. The processor sub-module **580** may provide a connection for a control signal to the light bulb **102** (shown in FIG. **1**). The lens sub-module **530** may be smaller than a common Heath-Zenith PIR sub-modules used in many light fixtures. However, the particular size of the lens sub-module **530** may be varied to meet the design criteria of a particular implementation. The lens sub-module **530** may be pivotable to provide a desired viewing angle.

Referring to FIG. **18**, a detailed illustration of the processor sub-module **580** is shown. The processor sub-module **580** generally comprises a block (or circuit) **602**, a block (or circuit) **604**, a block (or circuit) **606**, a block (or circuit) **608**, a block (or circuit) **610**, a block (or circuit) **612**, a block (or circuit) **614**, a block (or circuit) **616**, and blocks (or circuits) **618a-618m**. The circuit **602** may be implemented as a processor. The processor **602** may process input signals and/or generate various control signals. The circuit **604** may be implemented as a memory. The circuit **606** may be implemented as a speaker. The circuit **608** may be implemented as a microphone. The circuit **610** may be implemented as a Wi-Fi antenna. The circuit **612** may be implemented as a power adapter. The circuit **614** may be implemented as a connection port. The circuit **616** may be implemented as a sensor I/O block. The sensor I/O block **616** may include a number of sensor modules **618a-618m**.

The memory **604** may store images, audio, and/or other data. Data stored in the memory **604** may be compared to various signals from the sensor modules **618a-618m**. In one example, the data stored in the memory **604** may be a password. The processor **602** may compare the password with signals from the sensor modules **618a-618m**. The comparison may determine which control signals to generate.

The speaker **606** may generate audio signals. The speaker **606** may be implemented as one or more speakers. In one embodiment, the speaker **606** may be configured to generate a moderate volume sound (e.g., 75 dB at a range of 1 meter). However, the particular volume generated may be varied to meet the design criteria of a particular implementation.

In another embodiment, the processor sub-module **580** may be configured to stream audio signals from a mobile device, and/or other device within range of the processor sub-module **580**. The Wi-Fi antenna **610** may be configured to communicate with mobile devices, and/or other devices to send and/or receive audio signals. The connection port **614** may be configured to communicate with various devices to send and/or receive audio signals. The audio signals may be stored in the memory **604**. In one example, the speaker **606** may generate audio signals to attract outdoor wildlife and/or chase away undesired wildlife. The lens sub-module **530** may capture images of the wildlife. Images may be stored in the memory **604**. An alert may be sent to the user via the Wi-Fi antenna **610**, the connection port **614**, and/or other methods. In various embodiments, the speaker **606** may or may not be integrated on the board of the processor sub-module **580**. For

11

example, the speaker **606** may be separated from the processor sub-module **580** (to be described in more detail in connection with FIG. 20).

The microphone **608** may receive audio signals. Audio signals detected by the microphone **608** may be used by the processor sub-module **580** to generate various control signals. In one example, audio signals generated by a visitor may be received by the microphone **608** to generate a control signal used to control the light bulb **102**, and/or control a door (e.g., opening, closing, and/or locking a door). Audio signals detected by the microphone **608** may be used as an audio password. For example, voice recognition may be used to generate a password. The audio password may be needed to allow the processor sub-module **580** to generate various control signals.

The Wi-Fi antenna **610** on the processor sub-module **580** may receive and/or transmit data signals. The Wi-Fi antenna **610** may register electromagnetic signals, acoustic signals, and/or other signals. The Wi-Fi antenna **610** may provide control signals to turn on the light bulb **102**, create sound from one or more speakers, send alerts to users, and/or send other wireless signals.

The power adapter **612** may receive electrical power from the light bulb **102** and/or from a wall base **110** of the light fixture box **502**. Electrical power from the light bulb **102** may be presented to the processor sub-module **580** by a connection to the plug **582**. The power adapter **612** may convert the electrical power. The converted electrical power may provide a power supply to the various components attached to the processor sub-module such as the lens sub-module **530**, and the sensors **618a-618m**. In one example, the power adapter **612** may be implemented as a 5v power adapter.

The connection port **614** may provide a physical connection to various devices. The connection port **614** may be configured to communicate with various devices. In one example, the connection port **614** may be a Universal Serial Bus (USB) port. However, the particular type of port may be varied to meet the design criteria of a particular implementation. The connection port **614** may be configured to connect to an external device such as a computer and/or mobile device. The configuration port **614** may be configured to allow the user to have access to a Wi-Fi setup for the Wi-Fi antenna **610**, store data (e.g., audio files) in the memory **604**, configure the sensor modules **618a-618m**, and/or update firmware. The firmware may be stored on the memory **604**. The firmware may store instructions that, when executed by the processor **602**, implement one or more steps and/or control actions.

The sensor modules **618a-618m** may be implemented as environmental sensors. The sensor module **618a** may be an electromagnetic field sensor. The sensor module **618b** may be an acoustic field sensor. The sensor **618c** module may be a voice recognition sensor. The sensor module **618d** may be a facial recognition sensor. The sensor module **618e** may be a gesture sensor. The sensor module **618f** may be a weather sensor. The sensor I/O block **616** may include other sensors, such as a smart IP camera and/or a PIR motion detector to detect people and/or animals. The particular number and type of sensor modules **618a-618m** may be varied to meet the design criteria of a particular implementation. The sensor modules **618a-618m** may be interchangeable. One or more of the sensor modules **618a-618m**, or a combination of the sensors modules **618a-618m** may be implemented internally as part of the processor sub-module (e.g., within a housing **506**), or alternatively may be implemented externally (e.g., as a separate sensing device coupled to the processor sub-module **580**). Input received by the sensor modules **618a-618m** may be interpreted by the processor **602**. For example, input

12

received by the sensor modules **618a-618m** may be used to generate control signals. In one example, a control signal may be sent to the power adapter **612** to control the light bulb **102**. The control signals may also control the intensity, color and/or frequency of the light bulb **102**.

In one example, the electromagnetic field sensor **618a** may detect electromagnetic fields generated by appliances, other electronics, and/or other sources of electromagnetic fields within the range of the processor sub-module **580**. Disturbances in the electromagnetic field may be used by the processor **602** to detect potential visitors and/or other objects.

In one example, the acoustic field sensor **618b** may detect acoustic fields generated within the range of the processor sub-module **580**. Such disturbances in the acoustic field may be used to detect potential visitors and/or other objects.

In one example, the voice recognition sensor **618c** may be configured to recognize audio signals such as voices. The microphone **608** may present audio signals to the voice recognition sensor **618c**. Signals detected by the voice recognition sensor **618c** may be used by the processor sub-module **580** to generate various control signals. In one example, audio signals and/or a command voice may be needed (e.g., a password) to allow the processor sub-module **580** to generate various control signals.

In one example, the facial recognition sensor **618d** may be configured to recognize the facial and/or other features of a person and/or of other objects. Signals detected by the facial recognition sensor **618d** may be used by the processor sub-module **580** to generate various control signals. In one example, facial recognition and/or recognition of other features of a person and/or other object may be needed to allow the processor sub-module **580** to generate various control signals.

In one example, the gesture sensor **618e** may be configured to recognize gestures and/or movement of a person and/or other object. Signals detected by the gesture sensor **618e** may be used by the processor sub-module **580** to generate various control signals. In one example, a particular gesture and/or combination of movements may be needed to allow the processor sub-module **580** to generate various control signals.

In one example, the weather sensor **618f** may be configured to detect various weather variables such as temperature, humidity and/or atmospheric pressure. The weather sensor **618f** may be comprised of a photodiode. The photodiode may be configured to determine daytime, nighttime, and/or the amount of light in the environment. Signals detected by the weather sensor **618f** may be used by the processor sub-module **580** to generate various control signals. In one example, notifications about the weather may be sent to the user. In another example, the amount of light in the environment may be used to control curtains and/or blinds to prevent and/or allow a particular amount of light through a window. In another example, light intensity of the light bulb **102** may be increased as light in the environment decreases. An increase in light intensity of the light bulb **102** may ensure there is sufficient light for the lens sub-module **530** and/or other sensor modules **618a-618m** to properly function. Controlling light intensity of the light bulb **102** may eliminate the need for an IR light source in a camera during nighttime operation. The IR light source may be implemented in the light bulb **102**.

The lens sub-module **530** is shown connected to the processor sub-module **580** with the cable **584**. In various implementations the lens sub-module **530** may be integrated on the processor sub-module as part of the sensor I/O block **616**. The lens sub-module **530** may be used to detect potential visitors, and/or other objects. Signals detected by the lens sub-module **530** may be used by the processor sub-module **580** to generate

13

various control signals. In one example, the lens sub-module 530 may detect a visitor. A control signal may be generated to control the light bulb 102 and/or control a door. In another example, the lens sub-module 530 may detect an unwanted visitor. A control signal may be generated to prohibit the unwanted visitor from entering the premises, alert the homeowner, and/or contact proper authorities. The lens sub-module may work in combination with various sensor modules 618a-618m such as the facial recognition sensor 618d and/or the gesture sensor 618e.

Referring to FIG. 19, a processor sub-module and lens sub-module connected to a light fixture is shown. The lens sub-module 530 may be mounted on the housing 506. The processor sub-module 580 (shown in FIG. 17) may be mounted in the housing 506. In one example, the processor sub-module 580 may include the speaker 606. The processor sub-module may be connected to the light bulb 102 with a cable 660. In the example shown, the cable 660 is shown exposed. However, the cable 660 may be contained within the attachment 508 (shown in FIG. 15). The processor sub-module 580 may get power from the light bulb 102 and/or may provide a control signal to the light bulb 102. The cable 660 may connect to the plug 582 (shown in FIG. 17) on the processor sub-module 580.

Referring to FIG. 20, an example of an external speaker 670 separated from the processor sub-module is shown. The processor sub-module 580 is shown inside the housing 506. The external speaker 670 is shown moved up the housing 506, facing forward. Separating the speaker 606 (shown in FIG. 18) from the processor sub-module 580 allows the external speaker 588 to be positioned as desired by the user.

While the invention has been particularly shown and described with reference to the preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made without departing from the scope of the invention.

The invention claimed is:

1. An apparatus comprising:

a module comprising (a) an antenna module configured to connect and send data to a local network through a wireless connection and (b) a camera sensor configured to capture pictures of a surrounding environment of said apparatus; and

a processor sub-module configured to provide (i) a physical connection to said module, (ii) a connection between a power source and an external device, and (iii) control signals for activation of (a) said external device and (b) components of said processor sub-module, wherein (A) said pictures are sent as said data through said wireless connection, (B) said processor sub-module is fully enclosed within a base of a light fixture and (C) said module is integrated in a bottom part of said base that extends below a shade of said light fixture.

2. The apparatus according to claim 1, wherein (a) said components of said processor sub-module comprise sensors configured to detect fields generated by sources in a range of the apparatus and (b) disturbances in said fields detected by said sensors are used to detect potential visitors.

3. The apparatus according to claim 2, wherein said fields comprise at least one of (a) electromagnetic fields and (b) acoustic fields.

4. The apparatus according to claim 2, wherein (a) said antenna is further configured to register said disturbances and (b) said processor sub-module is configured to generate said control signals for at least one of turning on a light, creating sound from one or more speakers and sending alerts to users.

14

5. The apparatus according to claim 1, wherein (a) said antenna module is further configured to (i) connect to one or more mobile devices and (ii) send/receive audio signals and (b) said processor sub-module is further configured to stream said audio signals from a built in speaker component of said apparatus.

6. The apparatus according to claim 1, wherein (a) said external device is one or more doors and (b) said control signals are configured to control access to said one or more doors.

7. The apparatus according to claim 1, wherein (a) said control signals are generated in response to input signals received from said components of said processor sub-module and (b) said input signals comprise at least one of a voice password, a gesture password detected by said camera sensor and facial recognition.

8. The apparatus according to claim 1, wherein (i) one of said components of said processor sub-module is a speaker, (ii) said processor sub-module is configured to play sounds from said speaker to attract animals, (iii) said camera sensor is configured to record images of said animals and (iv) said recorded images of said animals are sent with an alert signal to a user.

9. The apparatus according to claim 1, wherein (i) one of said components of said processor sub-module is a speaker, (ii) said processor sub-module is configured to play sounds from said speaker, (iii) said sounds from said speaker are configured to chase away undesirable outdoor animals detected by said camera sensor, (iv) said camera sensor is configured to record images of said undesirable outdoor animals and (v) said antenna module is further configured to send an alert signal to a user.

10. The apparatus according to claim 1, wherein (a) said external device comprises a light bulb and (b) said components of said processor sub-module comprise one or more interchangeable environmental sensors.

11. The apparatus according to claim 10, wherein (a) said one or more sensors are configured to present input signals to said processor sub-module, (b) said control signals are configured to control said light bulb in response to said input signals and (c) said one or more sensors obtain a power supply from (i) said light bulb when operating in a first mode and (ii) from said base of said light fixture when operating in a second mode.

12. The apparatus according to claim 10, wherein said control signals comprise information to control at least one of an intensity, a color and a frequency of light from said light bulb.

13. The apparatus according to claim 10, wherein said light bulb comprises an LED light bulb.

14. The apparatus according to claim 1, wherein one of said components of said processor sub-module comprise speakers.

15. The apparatus according to claim 10, wherein said sensors comprise at least one of:

a smart IP camera;

a passive IR motion detector configured to detect at least one of (a) people and (b) animals;

a photodiode to determine daytime and nighttime;

a weather sensor configured to detect at least one of (a) temperature, (b) humidity and (c) atmospheric pressure; and

a microphone configured to capture sounds from the surrounding environment.

15

16. A method for controlling a light bulb, comprising the steps of:

- a) automatically providing control signals from a processor sub-module of a camera, said control signals configured to perform at least one of (a) turning on and (b) increasing a light intensity of an integrated light bulb when (A) there is insufficient light for the camera to perform and (B) a sound is detected by a component of said processor sub-module, wherein said processor sub-module (i) provides a physical connection to a module of the camera, (ii) provides a connection between a power source and the integrated light bulb and (iii) is fully enclosed within a base of a light fixture;
- b) implementing an IR light source in the light bulb of said light fixture;
- c) verifying potential visitors based on pictures of a surrounding environment, wherein said module (A) com-

16

prises (i) an antenna module configured to connect and send data to a local network through a wireless connection and (ii) a camera sensor configured to capture said pictures of said surrounding environment and (B) is integrated in a bottom part of the base of the light fixture that extends below a shade of the light fixture; and
 d) if the verification is negative, said control signals turn off the light integrated bulb.

17. The method according to claim **16**, wherein said method is implemented to eliminate a need for said IR light in said camera.

18. The method according to claim **16**, wherein said method is implemented to control said light bulb during night time operation.

19. The method according to claim **16**, wherein said camera is configured to control said light bulb.

* * * * *